

Duration Addition to electricitY Storage (DAYS)

Long-duration energy storage technologies
and applications

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Outline

- ▶ Context behind the ARPA-E DAYS program
- ▶ Technology-to-Market: application space and examples
- ▶ Technology solutions: program portfolio and some recent results

LDES value unlocked at high VRE deployment levels

Firming Output of Variable Renewables

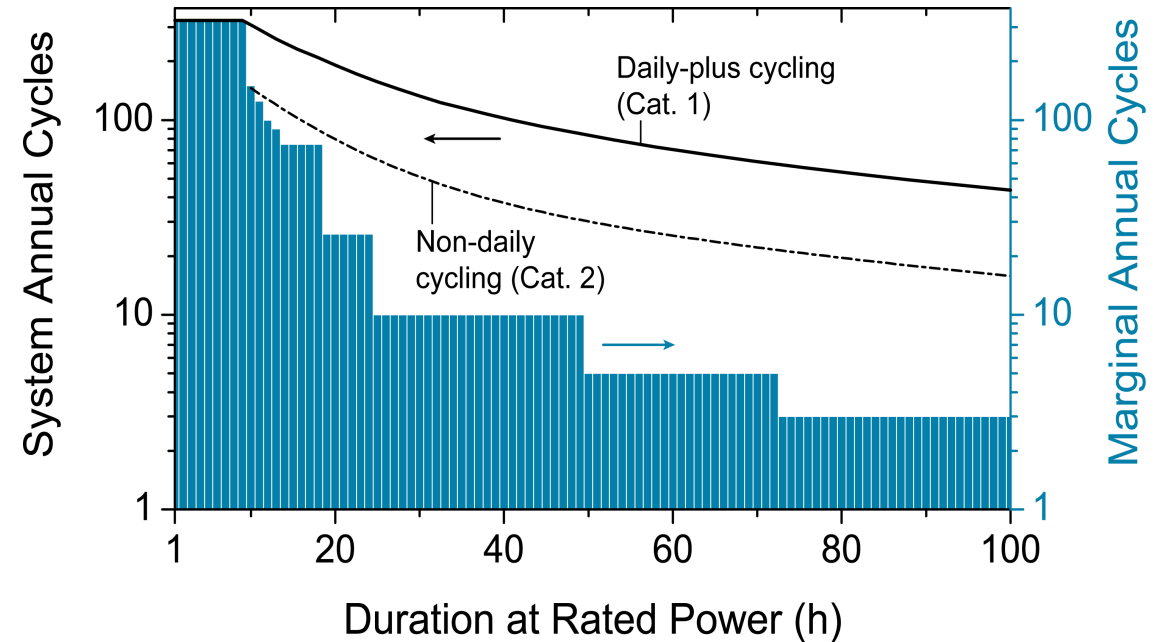
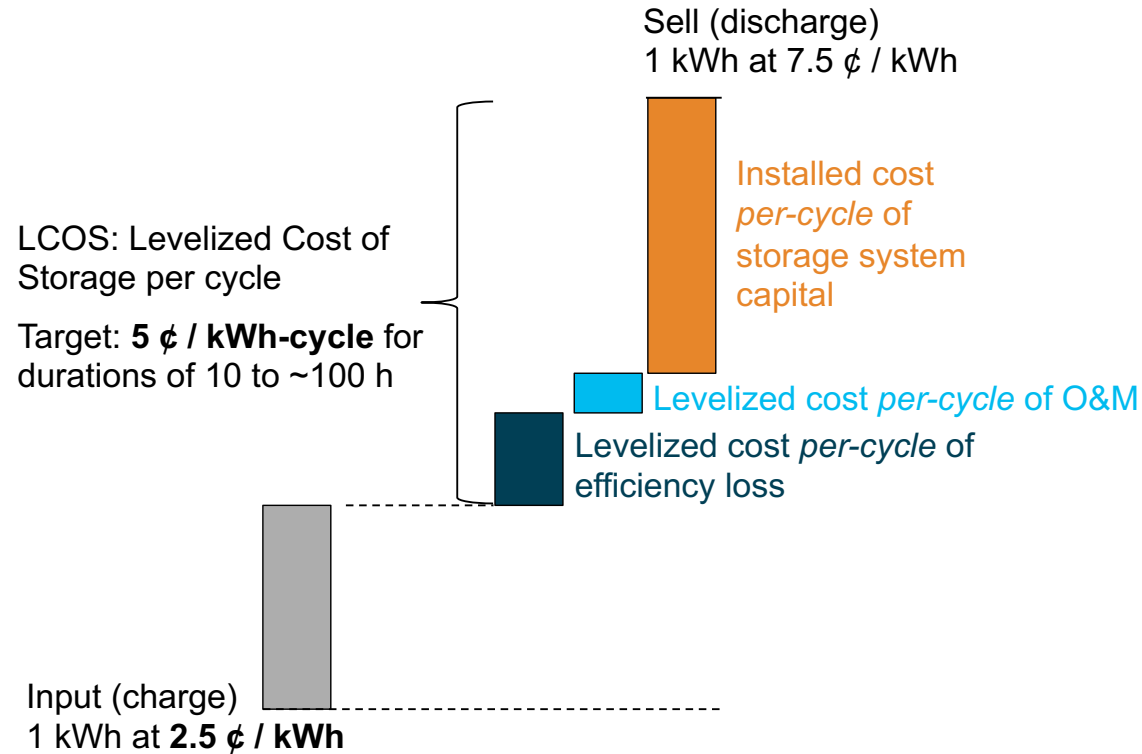


Ensuring System Resiliency



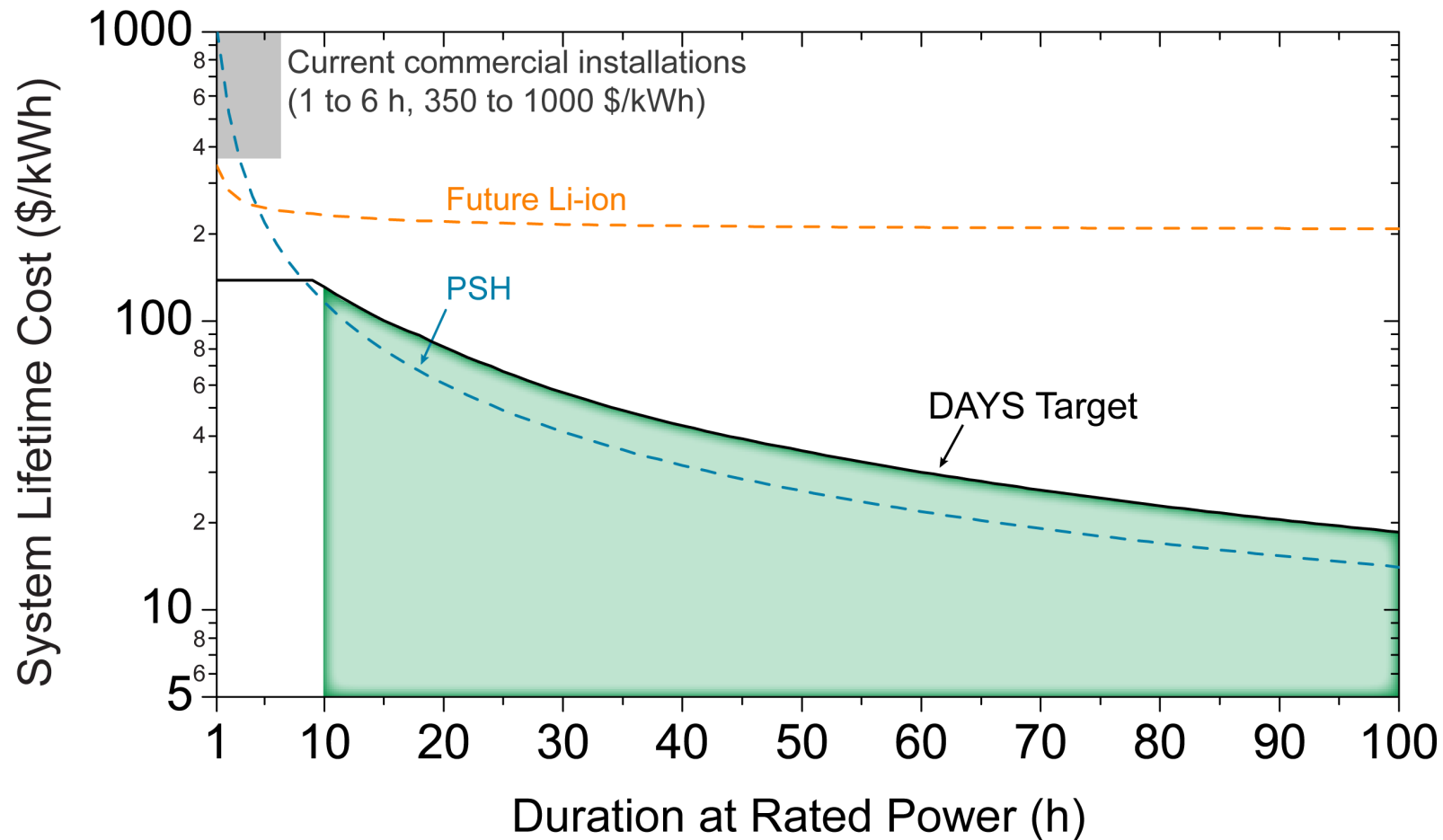
Back to the DAYS call: LCOS, duty cycle

Charge/discharge prices are rough estimates; not market projections



DAYS cost targets

10-100 hours of discharge at 5 ¢/kWh-cycle

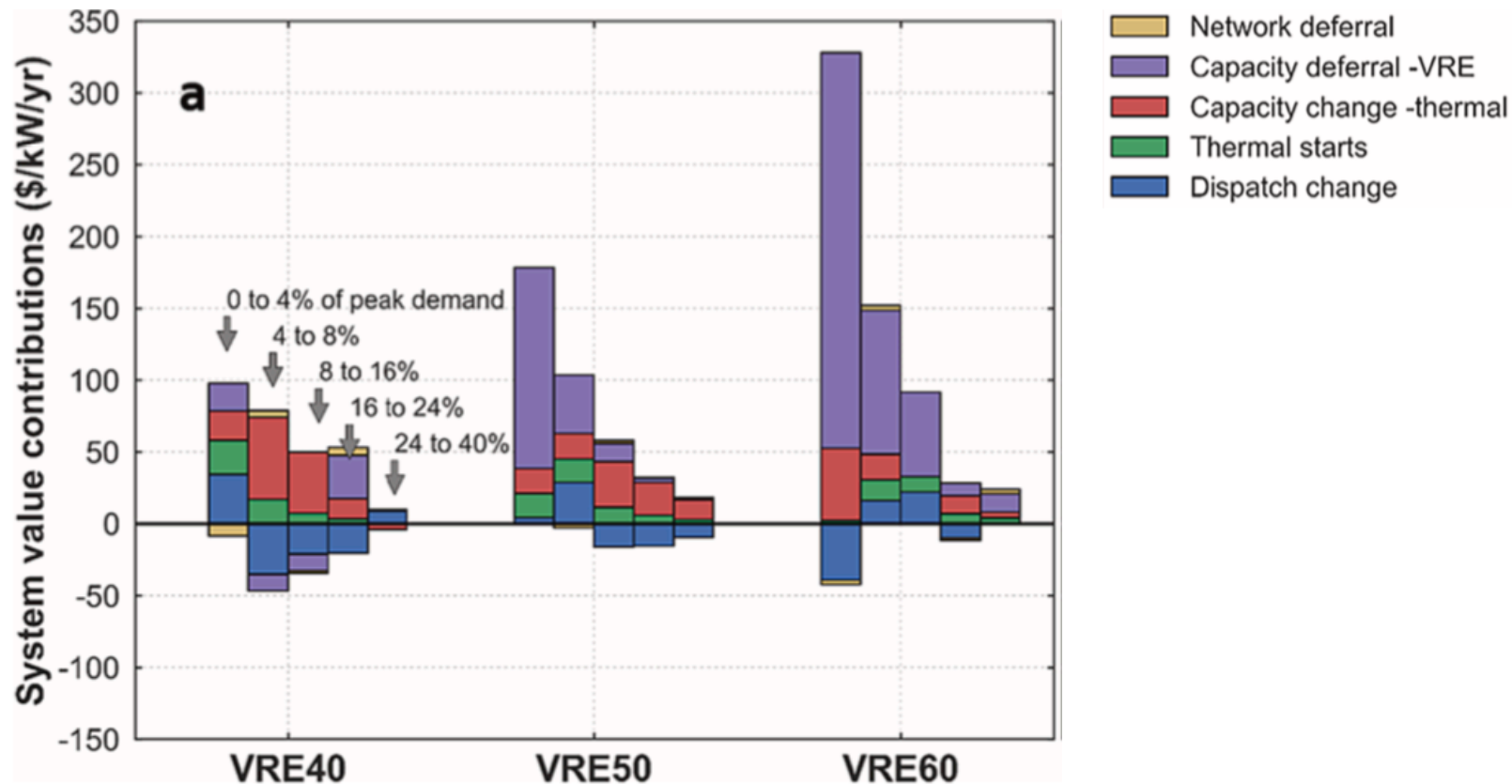


Focus has shifted more from LCOS to CapEx

TECHNOLOGY-TO-MARKET

Assessing system value, especially capacity

Factors comprising system value of 4-hour storage in the Northeast U.S. under different renewable and storage penetration levels



D.S. Mallapragada, N.A. Sepulveda, J.D. Jenkins, *Applied Energy* **275**, 115390 (2020)

Recent capacity substitution examples

Oakland to Swap Jet-Fuel-Burning Peaker Plant for Urban Battery

The deal with Vistra will be the largest standalone storage facility contracted for a community-choice aggregator in California.

JULIAN SPECTOR | JUNE 26, 2019



Peaker plant in Oakland replaced with 20 MW / 80 MWh of lithium-ion storage



Published: 19 Oct 2020,
10:41

By:



Andy Colthorpe
Editor

California Community Choice groups seek up to 500MW of long-duration energy storage

8 hours duration, in service by 2026

Understanding LDES value: stakeholder outreach

Financial Partners



Market Researchers



Utilities



OEMs



Trade Groups



Energy Buyers

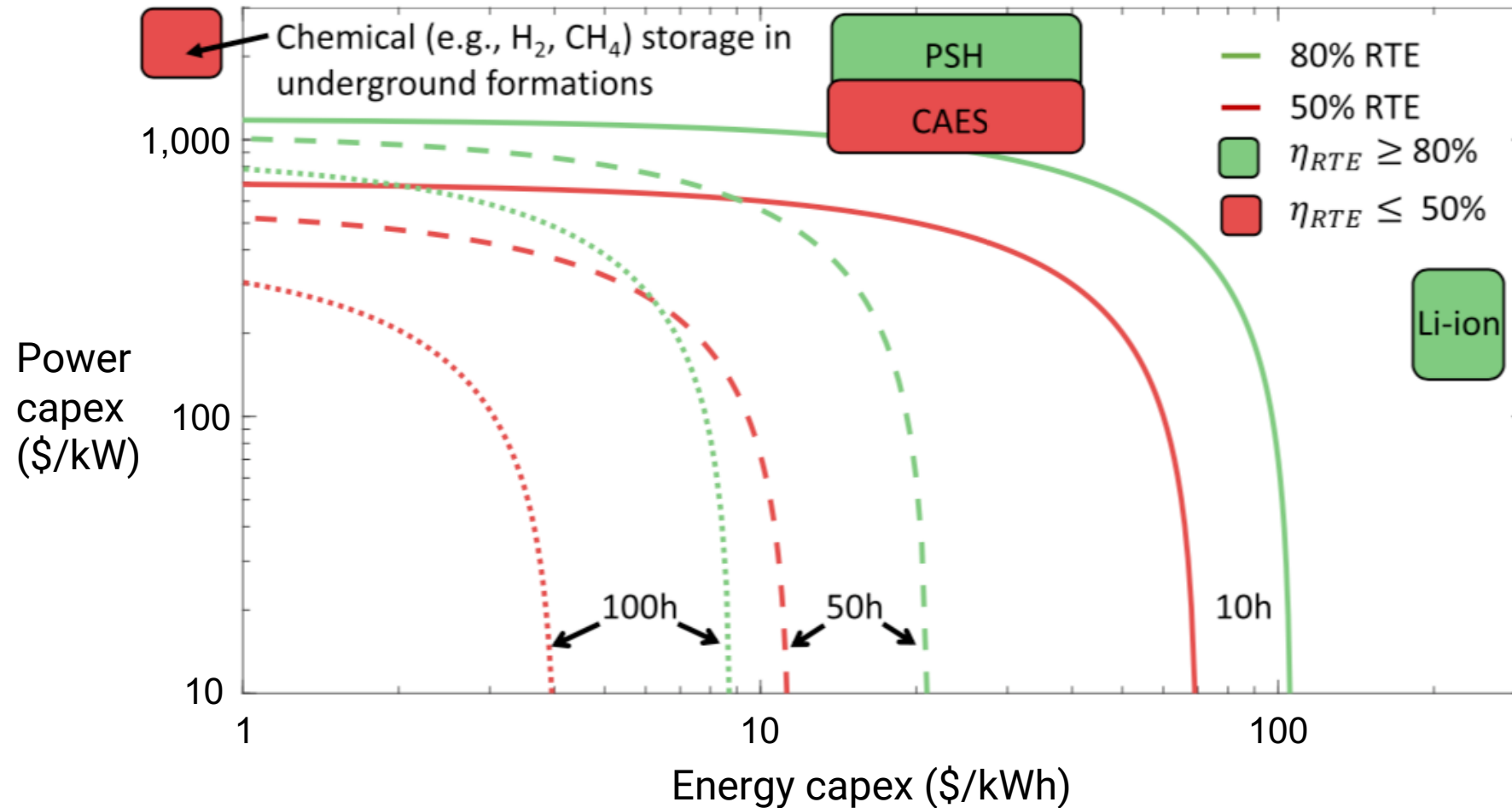


Public Partners



TECHNOLOGY SOLUTIONS

Desired technology cost structure



Assumptions

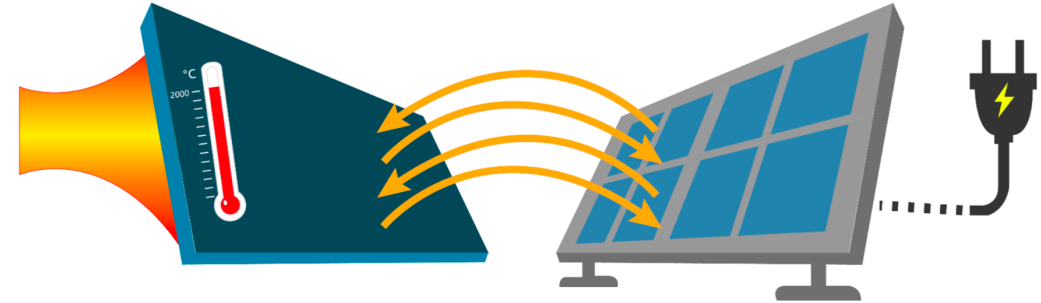
- \$0.05/kWh differential per cycle
- Certain duty cycle
- \$25/kW-yr capacity payment

The DAYS portfolio

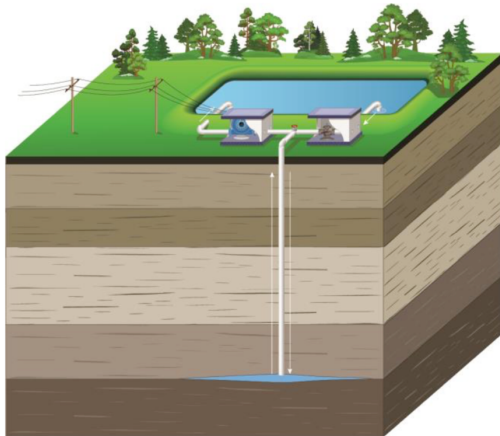
Thermal energy storage



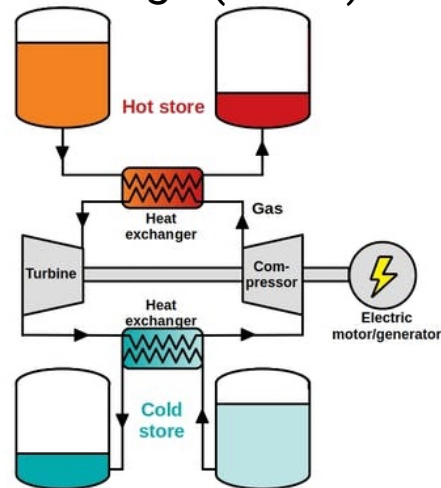
Thermophotovoltaic (TPV) storage



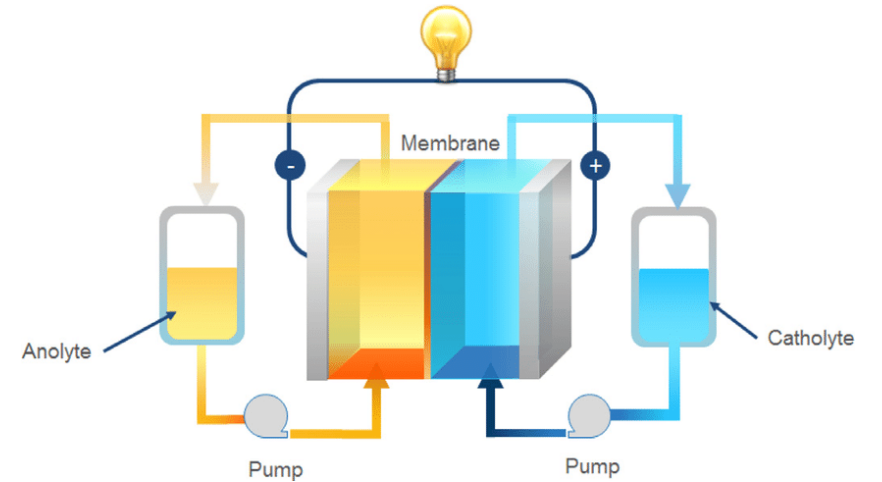
Geomechanical storage



Pumped heat energy storage (PHES)



Electrochemical storage

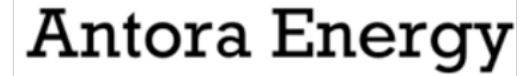


The DAYS technical portfolio

Thermal energy storage



Thermophotovoltaic (TPV) storage



Geomechanical storage



Pumped heat energy storage (PHES)

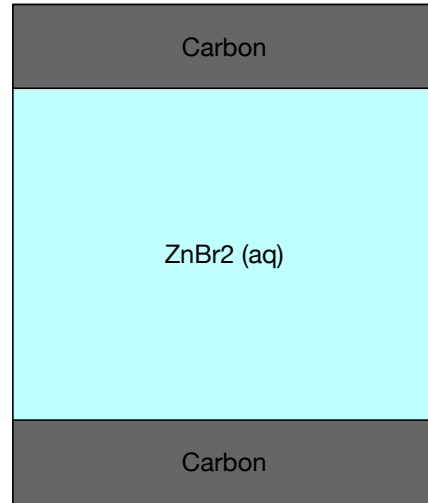


Electrochemical storage

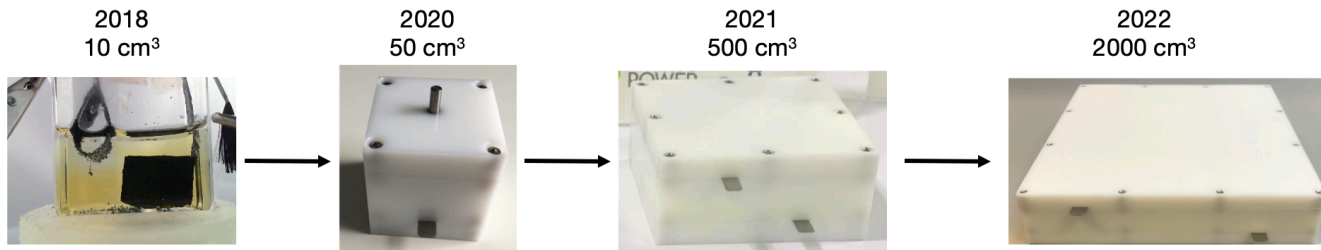
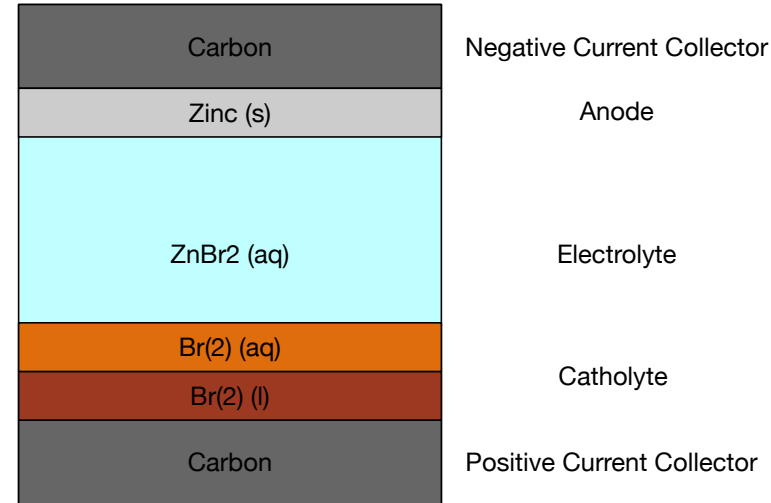


ZnBr₂ battery: simple design, cheap materials

Discharged

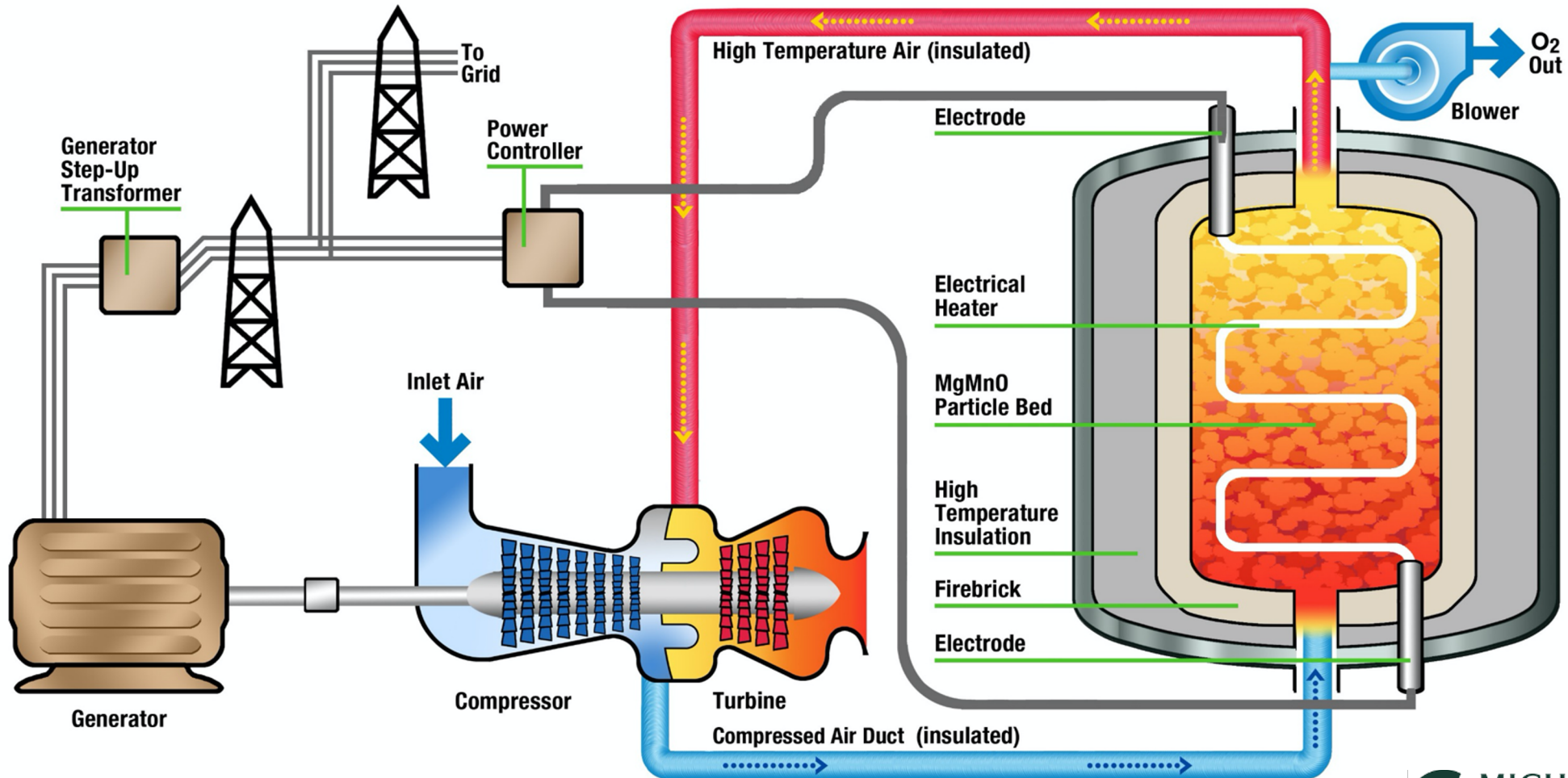
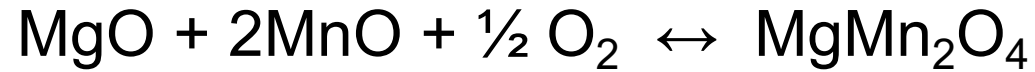


Charged



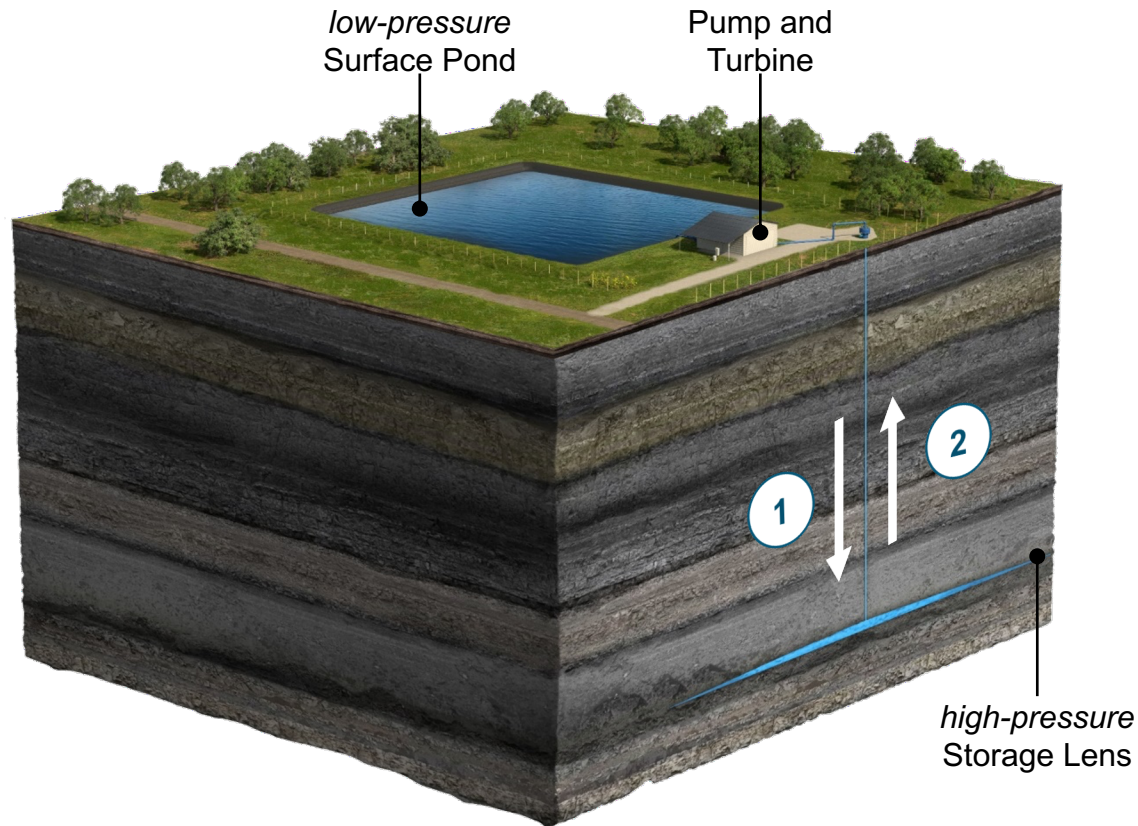
Metric	Before ARPA-E	Current	Target
Cell BOM	\$120/kWh	\$70/kWh	\$25/kWh
Energy Density	8 Wh/L	60 Wh/L	120 Wh/L
RTE	60%	68%	75%
Self Discharge	20% / day	10% / day	5% / day
Cell Size	50 mWh	20 Wh	200 Wh

Overview of the Technology: Thermochemical Storage



low-cost, long-duration geomechanical pumped storage

Quidnet stores energy as high-pressure water underground



Modular, long-duration storage

1-10 MW per well, 10+ hours

Structural cost position

<50% capex of battery & pumped hydro, <\$10 per marginal kWh

Broad geological footprint

100+ TWh across multiple US basins

Mature execution supply chain

- 1 **Charge.** Water pumped down the well into high-pressure storage lens
- 2 **Discharge.** High-pressure water flows up the well to drive a turbine

Summary

- ▶ LDES is a tool in decarbonization; serves a different role than storage today
- ▶ LDES is valuable at the system level, but need to translate that to individual customers
- ▶ The ARPA-E DAYS program and **others (see right)** are developing LDES technologies to do this

